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CENTRE FOR INSTRUCTIONAL TECHNOLOGY · SIR GEORGE WILLIAMS

CANADIAN

COMPUTER COMMUNICATIONS

FOR HUMAN DEVELOPMENT

Dr. Gary M. Boyd

Centre for Instructional Technology

Sir George Williams University,
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COMPUTER COMMUNICATIONS TO MEET CANADA'S
SOCIAL AND ECONOMIC NEEDS

G. M. Boyd.

Canada's social and economic needs in order of precedence may be specified as:

1.1 ORDERED QUANTITATIVE VALUE

To establish measures of value¹ for public goods (clean water, health, etc) and for the intellectual and aesthetic commodities of the knowledge industry. (Research, education, art, etc) so that a more rational balance of productive activity may be obtained.² This is the most important need because the optimum deployment of resources to meet other needs depends upon the ordering and quantification of values. This is not an impossible task because the potential entropy reduction value of any information to any self-organising system can in principle be estimated.³ In practice of course it is often a very difficult problem, but one which we are beginning to develop the tools to solve.⁴

1.2 ECONOMIC SUSTENANCE AND WORLD DEVELOPMENT

To establish international trade in a way which will provide sustenance for the development and employment of the most sophisticated talents with which Canadians are endowed, and to do so in such a way as to reduce the potentially destructive tensions between competing foreign governments.

Specifically: (a) to export knowledge to developing countries,⁵ and (b) to form agreements with other primary exporters to raise the prices of all raw materials (almost to the price of producing them from sea-water) thereby obtaining adequate compensation for resource depletion.⁶

Our long-term interests as producers of knowledge and culture and our short-term interests as exporters of primary products far outweigh our interests as consumers of manufactured goods.⁷

International co-operation of this sort is the second most important need because the resources available for our internal development are dependent on world trade, because internal social tensions are lessened by involvement in external projects, and because the gap between have-not and have nations must be narrowed to avoid fatal wars.⁸

1.3 FULL INVOLVEMENT OF HUMAN RESOURCES

To efficiently employ all our human resources⁹ for the development of Canadian society. This is not possible without realistic market values for intellectual aesthetic and 'public good' commodities and without favourable foreign trade. Development implies sustenance and beyond that such growth as is compatible with long-term survival.

Sustenance involves such things as preventive medicine and cultural sustenance (art, music, dance etc) as well as mere food and shelter for everyone. Growth must be growth in public sectors; justice, clean water, communications, transport, as well as in private ones. And those forms of growth which involve doing more with less are obviously to be preferred from an ecological point of view. (In particular growth of knowledge and art).

Finally it should always be kept in mind that the *raison-d'être* for our entire socio-economic structure is the development of 'better' people. Better not only in physical health, but in mental health, in problem solving ability, and in the elegance and co-operativeness of life styles.¹⁰

The current under-employment and unemployment of Canadians is probably the primary threat to internal political stability. And although political stability is not by any means the ultimate good, it is generally a pre-requisite for most sorts of valuable undertakings.

1.4 META SYSTEMIC REGULATION

To develop governmental systems which will function rapidly and effectively to connect and to disconnect institutions groups and individuals to and from each other, to prevent catastrophic socio-economic

breakdowns and to foster long-term development.¹¹

Such 'connection and disconnection' may be in the area of access to information or in the area of access to money or access to space, or to leisure.

One of the seriously damaging vicious cycles (positive feedback loops) in our society is the one leading to the implosion of population into the major cities. Disincentives in the form of taxation and space-use regulations, together with 'connection' in the form of cheaper rural communication and transportation would probably break this vicious cycle.

Meta-systemic regulation is necessary because what appears best for any one group may not be at all best for society at large.¹²

2. COMPUTER COMMUNICATION SYSTEMS

2.1 THE ESTABLISHMENT OF NEW MEASURES OF VALUE

In general value is established through a marketplace or exchange.¹³ Computer-communications can provide a marketplace for both public goods and for knowledge.

2.1.1 Public goods. Computer communications can enable universal referenda or plebescites to be held. Public goods can be advertised and sold in competition with one another (if not directly with private goods, perhaps by allowing everyone to specify the proportion

of hoh's (his or hers) tax dollar to be allocated to various governmental areas. Public institutions receiving inadequate support might be loaned money to advertise for a larger piece of the pie. The actual mechanics of this might involve a bar chart being presented and each voter being allowed to push proportions up and down on a trial basis being given feedback on the probable consequences of various allocations and then when satisfied the individual would transmit hoh's 'vote' and all the received bar charts would be summed to determine the major budgetary allocations.¹⁴

The initial bar chart presentation would show the budget proportions for the previous year. Hence the voter would have a guide for choice and the conservative majority would probably tend to ratify the first presentation with very little modification.

The total tax bill and mil rates might still be set by the usual government bodies. But some real democratic participation would be introduced into one major area, and that opportunity could be extended to every adult given an appropriate identification scheme. Such a system should be very popular and to the extent that advertising and

tutorial material would still be prepared by government departments a large measure of control would be retained by the government.

2.1.2 A MARKETPLACE FOR THE KNOWLEDGE AND AESTHETICS INDUSTRIES.

A suitable computer communications system would allow people to call for tenders for the solution of various problems, or for the provision of data, or for the provision of instruction or entertainment. It would also allow others to submit not only bids and proposals for requested 'information' but also to submit chunks of 'information' property to be copied and used by anyone for a fee. In this way a market and market values could be established for the knowledge industry.¹⁵

For this to work every major information processing system in any one field of endeavour covered would have to be on-line to permit policing to avoid stolen information. Such a system would replace present copyright and patent procedures in the fields where it is implemented.

Consider the field of computer programming for example. Anyone could advertise through the system for a programme to do a specific job. Anyone else could submit a programme and if it

satisfied the requirements, could be paid for it through the system. However, this would require that every major computer would have to be on line so that a programme vendor could request 'police checks' to make sure people weren't using his wares without paying for them.

It is arguable that all computers should be accessible to an information property agency for this reason; - the loss of privacy being repaid by the gain in opportunities to sell not only programmes but also data in a large market.

At the very least this assumes that national standard codes for describing programmes should be developed to facilitate their interchange. A code for describing data might be more difficult but it too could be very valuable. (Further discussion is contained in appendix 4.1). In the long run the computer communications system should be able to learn the value urgency and nature of the information it handles in order to facilitate routing to appropriate users with appropriate speed and accuracy. In the near future standard designational codes for these parameters will be required even if the system is programmed to make some routing, storage

and security appraisals on the basis of the identity of addressors and addressees.

2.2 INTERNATIONAL ASPECTS OF COMPUTER COMMUNICATIONS

Given the need to: a) establish solidarity with other under-developed primary producer countries, and b) to lessen the 'have - have-not' gap what can be done through computer communications ?

The simplest and most obvious step to take would be to provide free (subsidised) participation in Canadian computer utilities, data banks and CAI systems as a form of foreign aid. For instance a geo-stationary satellite built for domestic communication purposes could conveniently provide spill-over service to latin America. It is a nice question as to whether providing foreign aid communications via a satellite launched for the establishment of domestic communications would be acceptable to the U.S.A.

Some of the services which Canada has or is developing for internal needs which would be of interest to other developing countries are:

1. Natural Resource commodity marketing computer communications.
2. Geophysical exploration data processing
3. Meteorological (including weather satellite) data processing.

4. Computer assisted instruction systems (e.g. NRC) as well as hybrid video-computer communications systems (CATV)
5. CAI and PI curriculum materials particularly for TSS users in the sciences including computer science.
6. Document retrieval systems (The National Library, NRC and other major libraries).
7. Fisheries and agricultural data processing.
8. Computer based graphic arts and media production systems.
9. (Purely defensive), defence communications and data information services.

All of the above might be shared on a piecemeal, individually negotiated basis, or if one succeeds in establishing an on-line marketplace for information commodities, it would be necessary only to provide subsidized communication channels to extend participation to selected underdeveloped countries.

Although Canada is nominally only bilingual, in fact we have attracted immigrants from most areas of the world and have a tremendous potential for producing tailored versions or technical and educational materials for most of the underdeveloped countries. In particular educated East Indians living in Canada could make large contributions to their home country through an hybrid computer-video communications

16. Such activities would somewhat ameliorate the 'brain-drain' losses from under-developed countries.

It is probably that systems developments which would not be considered politically feasible for purely domestic purposes, either because of the peculiar divisions of responsibility enshrined in the BNA Act, or because the domestic market appears to be too small, would be feasible as foreign aid or combined domestic-foreign development projects.

2.3 HUMAN RESOURCE DEVELOPMENT

Human resources are not developed in isolation but rather in contact with the real work of society. Consequently the first and most important process in human resource development is placing people in contact with appropriate developmental activities. Actually this involves bringing together: where people are, where they'd like to be, and where they are needed. The 'space' in this metaphor being not merely geographical but also 'where people are at' in terms of knowledge, skills, and other capabilities. The individual's knowledge, behavioral repertoire together with his state of health, financial position and personal contacts constitute the dimensions in human development space. (see flowchart, fig. 1).

The first step in human resource development is appraisal of each individual in terms of these parameters. The second step is ascertaining the desires and ambitions of the individual (ACTIVITY-ASPIRATIONS). The third

step is examining the discrepancies, if any, between aspiration and capabilities. If there are no major discrepancies then placement may be investigated.¹⁷

If there are major discrepancies then training of some sort is required. If there are no opportunities of the sort desired, then the needs of society and the opportunities which do exist should be displayed in such a way as to help the individual revise his aspirations. If no suitable opportunities exist, the possibility of the individual creating his own opportunities should of course be entertained.

If the individual's target activity is one badly needed by society the training for it should be a paid job. If the target activity is not in demand then the individual should pay for the training requested to qualify him for it. This process should be entered voluntarily. The individual applicant should be able to withdraw from the process and perhaps also to erase his records at will if he paid for the training.

It is apparent that human resource development involves functions currently performed by a number of overlapping institutions. Canada Manpower, Educational institutions, Commercial personnel departments and various professional associations. All these

organizations will no doubt continue to function but none is comprehensive enough to facilitate really efficient human resource development on a national basis. All could obviously profit from a trans-Canada computer communications system connecting with a national human resource databank.

However, a suitably designed sub-system of a national computer communication system could do a great deal more than merely provide a databank. It could provide a new marketplace for the knowledge industry and a means for appraising information wares.

It could provide assessment, counselling, guidance, some training (Computer Managed Instruction) for each applicant on a personalized basis. This would be paid for partly by the candidates, partly by organizations requiring jobs to be done and partly by Canada.

Over a period of time the human resources development network will gradually supplement conventional labour marketing and training institutions. Just as labour was displaced from agriculture and is now being displaced from industry by more efficient technology labour will be displaced from large areas of the public services if these are rendered more efficient. By the end of the century a guaranteed annual wage at subsistence level plus 'freelance' work of all kinds (gardening to astrophysics) will

be the normal mode of life, if we can develop a suitable system to market knowledge-work.

SYSTEM ARCHITECTURE

An 'INFOWORK' computer communication system would not be a bulk carrier but rather would be matched to the processing capabilities of individuals. An individual can scan a few thousand bits per second, can input about 50 bits per second and output about 30 baud directly.

Individually one can output a few thousand bits per second by editing stored material. Hence a two way channel capacity of about twenty kilobits per second is adequate for communication with an individual provided an 'intelligent terminal' capable of buffering redundant information is employed. (even a television programme on the average involves only a few tens of kilobits/sec of non-redundant information.)

'Intelligent' terminals with local information storage and with addressing and labelling capabilities can be used as part of an hierarchically organized distributed switching and processing network which would have interfaces with the bulk processing and bulk memory systems currently in use or under development for commercial and governmental purposes.

The INFOWORK netwprks would have an high degree of integrity but could connect to and be disconnected from other data systems at the discretion of the national meta-control system.

3. SOME POSSIBLE POLICIES

3.1 INFORMATION APPRAISAL AND EXCHANGE STANDARDS

A national research project involving economists (welfare economics, econometrics), communications and information theoreticians, human communication experts (psychologists, anthropologists, sociologists) and legal experts in the fields of copyright and commercial property could be set up to develop standard algorithmis for appraising information and standard code formats for labelling chunks of information to facilitate routing storage and marketing through an INFOWORK network.

3.2 A policy of extending domestic computer communication capabilities on a selective basis to emerging nations who co-operate with us in primary product marketing policies might be developed, and at the very least would provide a means of supporting domestic systems. At best it might prove an indirect way of achieving more favourable balances of payments.

3.3 A policy designed to develop a marketplace and exchange for the knowledge and entertainment industries which

favours small group and individual contributions could go a very long way toward reducing unemployment and enriching our communal as well as personal lives.

Such a policy might involve the formation of a crown corporation to build and operate a skeleton network and to specify message format standards. This corporation would not be permitted to compete with existing communications and computer organizations in the field of bulk data transport and processing but would be restricted to handling data originating from or destined to small groups and individuals. It would not cut into the existing computing market but would be expected to create a new market for information and entertainment.

In addition a meta-control system to safeguard property rights and to modulate the flow of information in the interest of personal and national security will be required, not only to deal with the INFOWORK system but also to regulate the bulk information carriers and processors.

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Appendix 4.1

WIDE ACCESS ADAPTIVE COMMUNICATION SYSTEMS FOR HUMAN RESOURCE DEVELOPMENT

Gary M. Boyd
August 1971

Economic Considerations

Economic value depends on there being an adequate marketplace; adequate implying: accessibility, size, and the institution of standards of quantity and quality, and also of some medium of exchange in which there is general confidence. In this sense we have well developed markets for natural resources and for manufactured goods and some services, however, the 'knowledge industry' can be said to lack an adequate marketplace. This is one of the reasons even vocationally oriented schools train people for non-existent jobs. (Another reason is that training is generally established as a long drawn out process preceeding actual work.)

It is paradoxical that the easiest commodity to transport, information, is the one for which only the weakest sort of marketing arrangements exist. Perhaps the fact that exchange of information unlike exchange of commodities of more substantial sorts does not constitute a zero-sum game (if I give you information I still retain it.) has something to do with this situation. Traditional institutional arrangements have often made use of negative-sum game aspects of time spent in attendance (I can't waste your time in idle chatter without also wasting my own.) to offset the positive sum aspects of information exchange.

Hence tutors and teachers have frequently been paid in terms of pupil-contact hours rather than in terms of information gained by the pupil.

Technological advances such as printing, xeroxing and magnetic recording of audio and video signals have not only upset the nice relationship between exchange of information and expenditure of time, but have also upset the royalty collection arrangements which in some areas of endeavour have provided a market for information.

At present there appear to be three major options: I) a form of communism in which it is recognized that everything the individual does is the rest of opportunities provided by society and hence no specific reward (nor punishment) for any particular information processing act is required. Rather a guaranteed annual wage plus an overall ideological or religious commitment is all that is required. This system does work, monastic communities, Maoist peoples armies etc.) but the balance of propaganda or advertising must be overwhelmingly in favour of commitment to the ideological or religious ideals. Desires for consumer goods (even leisure) outside the reach of the guaranteed wage are not to be cultivated.

II A system of citations, with honour and resources being committed to those whose work is most frequently cited by others. This system works tolerably well in the field of scientific publication where the relationship between knowledge and massive commercial exploitation is distant and tenuous, and where devotion to the

ideology of knowledge for its own sake frequently attains to almost religious importance. An extension of this system rather than that of the market to the development of educational materials might provide a good solution to some knotty problems were it not for the need to co-exist with the system of often lucrative royalties paid to the compilers of textbooks.

III A system of communication and information processing providing an open market for information and information processing.

What is envisaged is a market in which tenders could be called for, for the solution of specific problems, a market on which one could place blocks of data or simply 'ideas' up for sale rather as stocks and bonds are sold today.

At present it would appear that the book-keeping sub-system in a universal computer-communications system might be the major sub-system requiring more memory and more processing capability to conduct its appraisals billings and security searches than would be required to store and process the information-commodities.

A wide-access computer communications utility which bills on the basis of information used, and pays contributors on the basis of market demand for information contributed would at first sight appear to be ruled out by the likelihood of the system drowning in its own accounting and appraisal activities. On second glance however, if one considers contemporary industrial enterprises the number of people (the most sophisticated information processing components) employed directly in dealing with raw and manufactured materials is far fewer than the number employed

in accounting and marketing and other secondary functions largely necessitated by the commercial procedures of our society. Hence a tentative estimate that two thirds of a computer-communications system might be occupied with advertising, appraisal, bargaining billing and policing, need not be a damning indictment of such a system. It must be emphasized that there is no necessity and little possibility of fully automating all these functions and that many will have to be (in the near future at least) performed by people on-line. (rather as telephone operators used to do the billing for long distance calls) The prospect of a new form of large scale employment should not be a dismaying one.

It may be argued that the costs of a wide access adaptive computer-communications system, and particularly the initial capital costs outweigh potential benefits and in any case cannot be met by Canada at the present time. Perhaps one reply is that most of the investment has already been made in the training of engineers and computer scientists who are currently under-employed or unemployed. The actual cost of hardware is not likely to be above 40 or 50 billion dollars even if virtually every adult in the country is provided with access to the system.¹

It must be remembered that labor costs are largely costs in terms of other projects that can't be undertaken. This is so because the major portion of the middle class is already directly or

¹In large systems, terminal and line costs outweigh CPU costs, - assuming a terminal cost of about \$5,000, and line cost per terminal of about \$5,000. (a dollar a foot times a mile of line) and then assuming 5 million terminals yields a 50 billion dollar price tag.

indirectly employed by various governments in Canada. (mostly in rather unproductive activities such as school-teaching or 'administration' of resources barely comparable to their own salaries.) In this preliminary paper it is impossible to attempt a more realistic evaluation of costs than the above. For example a great deal depends on the rate of implementation. However, some attempt will be made to sketch and estimate some benefits which may accrue from such a system, particularly in the area of the conservation and development of human resources.

At present it would seem that the political and religious climates in euro-americal society are such as to rule out common property in ideas on the one hand and the rather aristocratic idealistic honours through citations systems on the other. This leaves us either to bumble along with no adequate reward system for information processing work, or to seriously undertake the development of a system which will reward intellectual work in proportion to its usefulness in ensuring the survival and development of society.

4.1.2 Social Considerations

The basic problem in human resource development is the problem of ensuring that everyone has an opportunity to participate in mankind's struggle to survive and develop. The tragedy of the twentieth century is that very large numbers of people have no opportunity to contribute to the development of human culture nor even to our maintenance (food clothing shelter transport) activities in any personally meaningful way.

Specialists do the meaningful work and insurmountable professionally erected hurdles severely restrict admission to the ranks of the specialists. This is not a stable situation since we have enough of a democracy so that the 'useless' majority can cut off resources from the specialists and are doing so already to some extent.

Fear, and in particular fear of scarcity, is rooted very deeply in the fabric of our society. A great deal of effort goes into the protection of privileged positions, quite possibly more effort than is expended to create new wealth. Professional associations and trade unions erect monstrous barricades to severely limit the number of people permitted to do the particular sorts of work they are concerned with. These barricades provide a shelter for incompetence and also create employment for those that man them, notably staff in training and certification institutions. The underlying assumption is: that value is created mainly by the maintenance of scarcity, and that there is only a limited amount of desirable work to be done. These assumptions are not entirely false, but a necessary corollary to them is false: that long and specialized training is required to do sophisticated work. Most people are capable of learning the necessary skills for any particular task in a rather short time, hours or weeks, provided that they have a good basic education and are provided with a well engineered training situation.

Since most people are capable of being taught a wide range of

specific skills as needed there is no reason to fear a shortage of any particular kind of work as some other sort of equal sophistication can always be substituted. Human beings are the general-purpose machine par-excellence..

Another reason for people being tied to particular work is the way in which primary relations groups are formed among workers performing related tasks. If the tasks are assembled into standardized roles which involve skill and danger a mythology develops which helps to bind the primary work group together very firmly, and strongly mitigates against re-arrangement of tasks and re-training. Perhaps the most obvious example is that of railroad men. Not only have locomotive engineers such as Casey Jones been elevated to mythical status, but also telegraphers, conductors, and yardmen have their archetypal heroes. The net effect was nicely summarized in a Punch cartoon showing a train crew walking hand in hand down the overgrown roadbed of an abandoned line. One woman in an adjacent backyard is saying to another: "They are so regular you can set your clock by them ! " When the work role in itself becomes a social work-of-art to be preserved as an end in itself than efforts toward efficiency and development are stymied. It is unlikely that the human penchant for ritualized roles can or should be suppressed, but roles which include as their central aspect the ability to do all sorts of work (Peter the Great, or Thomas Jefferson or Sir Christopher Wren might serve as archetypes) must be fostered. Purely ceremonial

roles entirely unrelated to work such as those of the Shriners or various athletic and religious institutions do serve as substitutes for work centered roles, but work without any role attachment probably seems an impoverished sort of life to most people.

Computer-communications systems make possible the farming out of individual tasks to anyone on the system who is able to perform them and wishes to do so. In fact by providing Computer-Assisted-Instruction modules the system may train people who wish to perform certain tasks but lack particular skills or knowledge. In short, with a wide access adaptive computer communications system everything can be 'up for grabs'. Real problems are almost invariably inter-disciplinary or perhaps a-disciplinary. In the past the division of knowledge into disciplines has had some value from both analytic and institutional points of view. But now that the unity of knowledge is apparent not only theoretically but practically (- everyone does an appreciable part of hoh's work on information processing machines) specialisation is needed only in rather narrowly bounded task areas. A basic education in general systems theory and cybernetics with the development of real behavioral problem solving capabilities in mathematics, interpersonal communication, logistics and philosophy, provides the core of a contemporary general purpose education to which specific skills and knowledge can be appended as needed to compete in the knowledge processing marketplace.

Obviously the transition from a world of work almost hopelessly

balkanized into 'professional states' to a world where everyone can vote with his feet is not likely to come about overnight, still it is the direction we should work toward for long-run economic efficiency and for extended social well-being.